

STUDY OF SHAPE OF ADMINISTRATIVE AREAS IN INDIA

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ABSTRACT: The shape analysis of administrative areas in Punjab revealed that there was a general improvement in shape efficiency of administrative areas from the higher to lower levels. The shape efficiency index was noted as the highest for development blocks, moderate for districts and subdivisions, low for divisions, and the lowest for the state. The impact of physical features, state's profile and administrative history of Punjab was clearly evident on the shape of administrative units. Districts along the rivers acquiring elongated shapes, peripheral districts having triangular shapes and Kapurthala district formed of former princely territories still being fragmented into parts, are some examples of such influences. The shape efficiency of administrative areas located in the erstwhile British Punjab was of higher order than that of those located in the former princely states. The successive reorganisations of the state after Independence improved the shape efficiency of several administrative areas. Notably, the newly formed administrative areas had generally higher shape efficiency than their predecessors. While there was a positive relationship between the relative shape efficiency of districts and that of their subdivisions, no such association was observed between the shape efficiency of districts/ subdivisions and that of their development blocks. This was attributed to the evolutionary process of the districts/subdivisions on the one hand and of the development blocks on the other. The former evolved simultaneously over a long span of centuries, the latter were a recent post-Independence product.

All administrative areas have their specific shapes which differ not only from those at different levels of hierarchy but also at the same level. Even the same area may take on different shapes if defined separately in terms of time-space, cost-space or effect-space (Massam, 1972, p. 2).

Blair and Bliss (1967) defined shape as that quality of an object which depends on position and distance of all the points composing its outline or external surface. Shape stands for a set of properties described as compactness, elongation and others. The ideal compact shape is a circle because it has the minimum length of boundary for a given area.

Compact shapes are generally more conveniently managed. These facilitate administrative functions which involve movements of people or goods. These favour the development process by way of rendering economy in provision of infrastructural facilities, like schools, hospitals and roads. Administrative supervision also becomes effective as remote localities are reduced in number.

Thus, the shape of administrative areas has its significant role in influencing the development process in spatial context. The shape is one of the attributes of spatial structure (such as, hierarchy, size (area and population), shape, location of headquarters, intra-unit administration and accessibility) of administrative areas having influence on the

development process individually as well as in unison. This makes the quantitative analysis of the shape of administrative areas worthy of research investigation. Because any attempt in the direction of reforming inefficient shapes of administrative areas can only be taken up after we have qualitative analysis of existing shapes at our disposal. The geographers have devised a number of methods of measuring the shape of geographic phenomena, depending upon their purpose. For example, while making an analysis of the shape of administrative area, a due note is needed to be taken of an already existing administrative centre, uneven pattern of population distribution, and specific channels of population mobility. So, it is not the method of measurement but the purpose which is more important.

Here, in this paper, an attempt has been made to examine critically the different methods of measuring the shape of geographic phenomena available in geographic literature and to find out the method most suitable to measuring of shape of administrative areas. For the purpose, administrative areas of all hierarchical order in general purpose administration of Indian state of Punjab have been selected as a case study. Since, to carry out such a study for India as a whole would involve monumental work, it is restricted to the single state of Punjab. Punjab is relatively the most prosperous and progressive state of India (Gosal and Krishan, 1984, p. 5). Its per capita income of Rs. 3,560 (approximately 300 dollars) in 1983-84 was the highest among all the 24 states in the country at present. A study of the shape of administrative units in Punjab would have a lead for conducting such studies for other Indian states.

Also, the paper intends to examine the following questions: (i) What spatial variations do exist in shape of administrative areas in different parts of the state? (ii) At what level of administrative hierarchy in Punjab shape of administrative areas was relatively efficient? (iii) Has the triangular shape of the Punjab any influence on the shape efficiency of peripheral districts in the state? (iv) Has evolutionary process of different types of administrative areas its imprint on their shape? What are the historical, administrative or geographical factors which played a leading role in the determination of shape efficiency of different administrative areas in different parts of the state? (v) What negative or positive effects, the successive reorganisations through which Punjab has had to pass had in its history? and (vi) Whether the shape efficiency of the newly organised administrative areas differ from their predecessors?

In the discussion to follow, answer to these and some other interrelated questions will be attempted. To start with a review of the quantitative methods devised by the geographers for measuring of shape of geographic phenomena will be detailed upon to pinpoint the method most suited to the measurement of the shape of administrative areas. And then a discussion on shape analysis of divisions, districts, subdivisions and development blocks in Punjab will take place. There were 3 divisions, 12 districts, 45 subdivisions and 118 development blocks in Punjab.

A Review of Quantitative Methods of Shape

Several geographers have tried to define the shape of geographic phenomena. They devised different measures of shape suited to their purpose.

Bunge (1962) identified the shape of ninety seven Mexican communities. He used a series of alternate distance measurements between vertices of derived polygons which were fitted over different shapes. Shapes ranged from elongated bars, through compact squares to elongated stars.

Haggett (1965) studied a sample of municipios in Brazil. He counted the number of neighbours touching each unit. The mean 'contact number' of administrative units was found as 5.71.

Pedersen (1967) extended Haggett's approach to the study of 553 administrative communes in Jutland and Fyn in Denmark. He found the mean 'contact number' as 5.83.

Boots (1979) examined the shape of districts in India. He found their mean contact number as 5.9 and modal number as 6.

These findings conform to the theoretical ideas of Christaller. Haggett and Chorley (1969) have, however, pointed out that this number should not be interpreted to indicate the existence of a hexagonal net structure. Blurring of basic triangular or quadratic nets could give very similar averages.

Dacey (1963), after examining some of the theoretical basis of contact numbers, had earlier concluded that a value close to six was inevitable for a large number of patterns, including the random ones.

Lee and Sallee (1970, pp. 555-563) used a more rigorous shape measure in their study of twenty-five villages in northern Sudan. A village map was overlain by a circle drawn in such a way as to minimize the area of 'non-fit' between the village and the circle. The

ratio between the area of the two was calculated. Finally, the shape of each village was referred to four standards, including circle, square, triangle and rectangle.

In their study of administrative areas in Southern Ontario, Massam and Burghardt (1968, pp. 125-134) and Massam and Goodchild (1971, pp. 193-206) devised a measure of shape efficiency. 'Shape efficiency' was defined as the ratio between distances travelled by the population to the actual administrative centre, such as mean centre of the population distribution. An identical location of the actual and optimal administrative centres will yield a high shape efficiency index of 1.

Frolov (1975 pp. 676-687) described the situations in which different shape indices were used. At least fifteen methods of measuring shape were identified. He classified these into eight categories on the basis of method of measurement used. He found greater promise in Bunge's inscribed polygons.

In sum, the choice of technique for measurement of shape will be guided by the purpose of the exercise. In the case of administrative areas, a due note is to be taken of an already existing administrative centre, uneven pattern of population distribution, and specific channels of population mobility (Yeates, 1974). Therefore the choice should fall on such a method of measuring the shape of administrative areas which satisfy all these conditions. Shape efficiency index devised by Massam and Goodchild (1971) tends to satisfy most of the requirements.

Therefore, the present study follows the 'shape efficiency' method used by Massam and Goodchild (1971). Various steps involved in the calculation of the

'shape efficiency index' are described below.

Methodological Steps

Since the method is based on the concept of 'moment of inertia', therefore, 'moments of inertia' were calculated with reference to both actual and optimal locations of headquarters of the administrative area under consideration. The optimal location was represented by the mean centre of population distribution.

The formula used for calculating the 'moment of inertia' was as follows:

$$(i) \quad M = \sum_{i=1}^j (d_{ij})^2 m_i$$

Where

M = moment of inertia; d = straight line distance between the administrative centre and the centre of lower order administrative units; and m = population of the lower order administrative units represented at their centres.

In the next step, index of shape efficiency (E) of any administrative area was calculated by dividing the optimal 'moment of inertia' by the 'existing moment of inertia'.

If the location of the administrative centre coincided with the men centre of population distribution the 'shape efficiency' index worked out as one. Greater the gap between the two, the lower the shape efficiency.

In the present study, district headquarters were taken as the control points for measuring the shape efficiency of the state and divisional headquarters. For measurement of shape efficiency of districts, the subdivisional headquarters, and for subdivisions the development

block headquarters were adopted as the control points.

Accordingly, villages should have been adopted as the control points in the case of development blocks. But considering the enormity of work involved, a modified form of the shape efficiency measure was devised. Its computation was as follows :

- i) Headquarters of a development block is located.
- ii) Median point of area, in place of centre of population, of the block is identified.
- iii) Six points, making a hexagon around the median point, are marked on the perimeter of the block.
- iv) Moment of inertia is calculated with reference to the block headquarters and the median point of area of the block.
- v) Finally the 'shape efficiency' index is calculated by dividing the 'moment of inertia' value for median point of area by that for actual headquarters of the block.

Now, the shape analysis of administrative areas in Punjab is done in the following discussion :

Shape Analysis of Administrative Areas in Punjab

Punjab as a whole showed a shape efficiency index of only 0.30. This was quite low. Its triangular shape and the peripheral location of its headquarters at Chandigarh were responsible for this.

Divisions

Among the three divisions, Jalandhar recorded the highest shape efficiency index of 0.50, and Ferozpur, the lowest of 0.26. The index value for Patiala was

0.45. Notably, the shape efficiency index of Ferozpur division was lower than that of Punjab (Table 1).

Table 1

Punjab : Shape Efficiency Index of divisions, 1981

| Division | Index value |
|-----------|-------------|
| Jalandhar | 0.50 |
| Patiala | 0.45 |
| Ferozpur | 0.26 |
| Punjab | 0.30 |

Districts :

Major physical features, specially rivers, have always been crucial in defining the boundaries of administrative units, like districts of Punjab. This was more than obvious during the Mughal rule when districts corresponded with interfluvial tracts. The Sikh rule also did not see any change in this regard. The importance of rivers as administrative boundaries did not diminish even during the British period. The princely states were, however, a highly fragmented affair. Each state was divided into a number of detached territories, varying in size and shape.

At the time of Independence in 1947, Punjab was composed of two types of administrative areas : the British ruled districts, and the native states. The former were much more consolidated and compact. The latter were fragmented and irregular in disposition. This legacy could not be completely wiped out even when attempts were made to refine the boundaries of erstwhile princely states, adopted later as districts. Kapurthala district, which was earlier a princely state,

remains fragmented into two parts till this day.

The triangular shape of Punjab was not without an effect on the shape of its districts, particularly those located in its northern part. Gurdaspur and Jalandhar displayed a triangular shape.

Elongation of districts along river courses was another noticeable feature. Ludhiana and Ferozpur along the Satluj, and Kapurthala along the Beas were the instances of this nature.

The shape of Rupnagar and Hoshiarpur districts was influenced by the orientation of the Siwalik hills. These districts follow their disposition.

Shape efficiency indices were calculated for all the districts. Their mean was found as 0.69. The comparable figure for divisions was 0.40. It shows that the disposition of districts in relation to their headquarters was far more satisfactory than that of divisions.

The shape efficiency indices of districts differed. These ranged from only .28 in respect of Bathinda to 1.0 for Gurdaspur district (Table 2). The coefficient of variability was 39 per cent. The shape efficiency of Bathinda district was undermined when one of its tahsils, along with two tahsils of Ferozpur district, were merged to form a new district of Faridkot. Kapurthala district, detached into two parts, was also noted for a low shape efficiency index of 0.32.

The case of newly formed Faridkot district was different. It recorded a high shape efficiency index of .89. Rupnagar district, formed at the time of Punjab reorganisation in 1966, also showed a high shape efficiency index of 0.93. This indicated that newly formed districts generally had more efficient shape, sometimes at the cost of their predecessors.

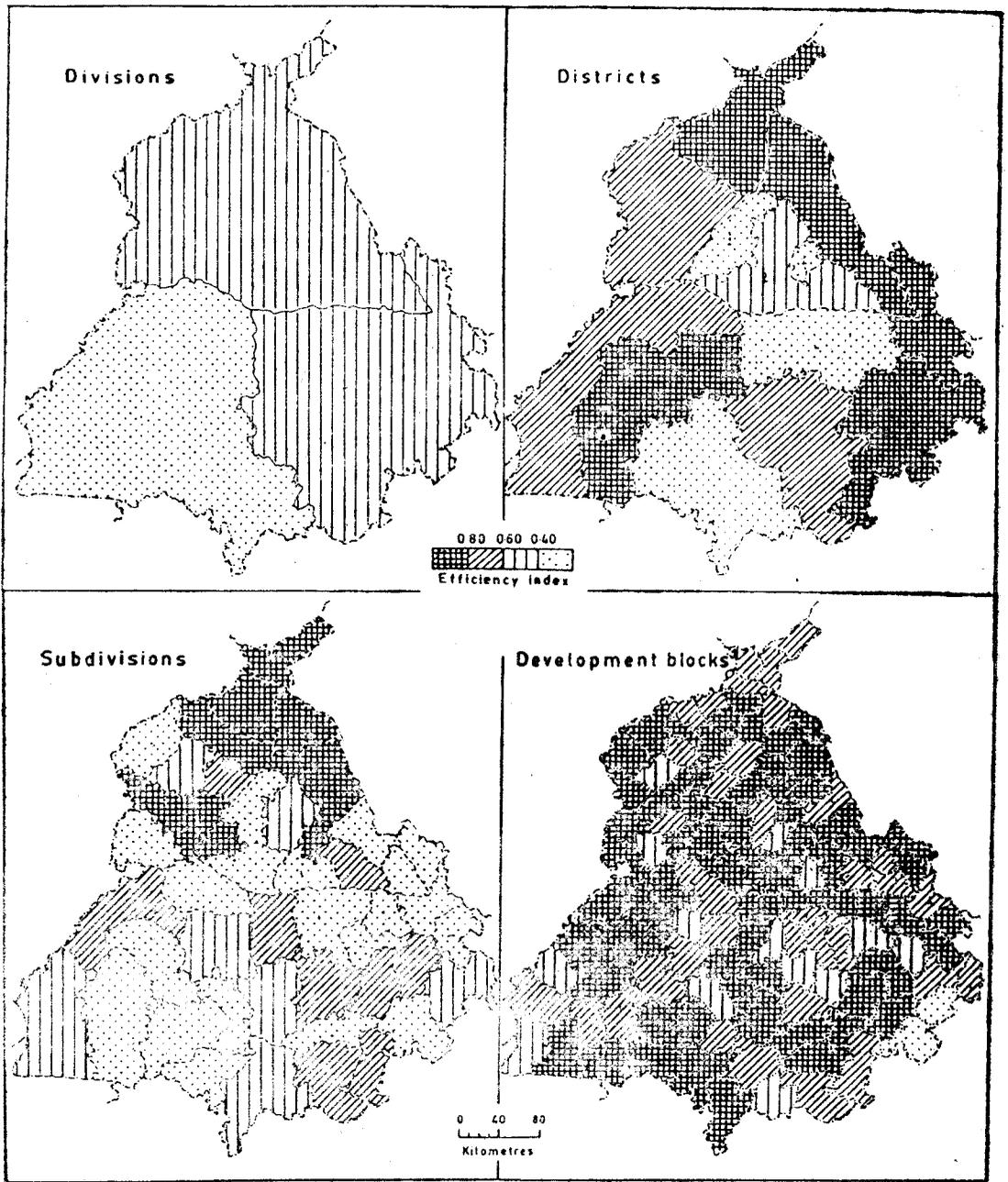


Fig. 1

Table 2

Punjab : Districts Classified by Shape Efficiency Index, 1981

| Shape efficiency index | Districts |
|------------------------|---|
| More than 0.80 | Gurdaspur (1.0) Hoshiarpur (.99), Rupnagar (.98), Faridkot (.89), and Patiala (.88) |
| 0.80 — 0.60 | Amritsar (.77), Sangrur (.76), and Firozpur (.64) |
| 0.60 — 0.40 | Jalandhar (.48) |
| Less than 0.40 | Ludhiana (.35), Kapurthala (.32), and Bathinda (.28). |

Average = .69 Standard deviation = .27
Coefficient of variability = 39 per cent
Subdivisions

An average shape efficiency index of 0.50 was recorded by subdivisions. The comparable figure for districts was 0.69. Subdivisions had lower shape efficiency than districts.

The shape efficiency indices for subdivisions ranged from the lowest of only 0.11 for Rampura Phul to 0.98 for Gurdaspur and Batala. The coefficient of variability was 52.7 per cent as compared with 39 per cent for districts. Subdivisions differed more than districts in shape efficiency.

Nearly half of the subdivisions recorded an index value of less than 0.40. These included all the three subdivisions in Rupnagar district and three each in Bathinda and Amritsar districts. Two subdivisions, each in Ludhiana, Jalandhar,

Faridkot and Hoshiarpur districts, also fall in this group (Table 3). Gurdaspur was the only district where none of the subdivisions showed such a low index value.

The shape efficiency of Sadar subdivisions (with the district headquarters located in them) conformed to that of their districts. Gurdaspur, Hoshiarpur and Firozpur recorded high shape efficiency indices both as districts and subdivisions. On the other hand, Ludhiana, Bathinda and Jalandhar recorded low shape efficiency indices both as districts and subdivisions.

Seven subdivisions were created after reorganisation of Punjab in 1966. Most of these recorded higher shape efficiency index than their predecessors.

Map 1 shows that the shape of subdivisions located in the former princely state territories was generally less efficient. The erstwhile British territory was noted for a comparatively higher shape efficiency of subdivisions.

In brief, shape efficiency of subdivisions was lower than that of districts. However, a higher shape efficiency at the district level was reflected in higher shape efficiency of its subdivisions also.

Development Blocks

The 118 development blocks in Punjab were, as a rule, internal components of subdivisions. Some exceptions did exist. Sangat and Phul blocks in Bathinda district, Samrala in Ludhiana, Sirhind in Patiala, and Jandiala in Amritsar, spread over to more than one subdivision. These blocks were initially a part of single subdivision. At some stage, when some villages of a particular block were transferred to an adjoining subdivision or to a newly created one, it

Table 3

Punjab : Subdivisions Classified by Shape Efficiency Index, 1981

| Shape efficiency index | Subdivisions |
|------------------------|--|
| More than 0.80 | Gurdaspur (.98), Batala (.98), Sultanpur Lodhi* (.97), Hoshiarpur (.96), Pathankot (.94), Phagwara (.88), Dasua (.83) and Tarn Taran (.81) Total = 8 |
| 0.80 — 0.60 | Baba Bakala* (.74), Ferozpur (.72), Nawashahr (.70), Nabha (.70), Sunam* (.70), Fatehgarh Sahib (.64), Malerkotla (.62), Samana* (.61) and Jagraon (.60) Total = 9 |
| 0.60 — 0.40 | Mansa (.59), Fazilka (.58), Moga (.54), Jalandhar (.51), Rajpura (.49), Amritsar (.48) and Barnala (.41) Total = 7 |
| Less than 0.40 | Bathinda (.39), Balachaur* (.35), Sangrur (.34), Samrala (.32), Kapurthala (.30), Muktsar (.29), Ajnala (.27), Patti (.27), Khanna* (.27), Talwandi Sabo* (.27), Garh Shankar (.26), Zira (.26), Ludhiana (.23), Patiala (.23), Anandpur Sahib (.23), Rupnagar (.23), Kharar (.22), Nakodar (.21), Faridkot (.20), Phillaur (.19) and Rampura Phul (.11) Total = 21 Grand total = 45 |

Average = 0.50

Standard deviation = .26

Coefficient of variability = 52.7 per cent

* Subdivisions created after Punjab's reorganisation in 1966.

happened to assume an inter-subdivisional character.

Headquarters of eight development blocks, namely, Moga II, Bajwara, Jalandhar East, Ludhiana, Ghanaur, Bhunerheri, Ahmadgarh and Khuian Sarwar were located outside their territory. An advantage was taken of the presence of some nearby big town to serve as headquarters. The shape effici-

ency of such development block was, of course, adversely affected.

The mean shape efficiency index for all the development blocks was noted as 0.79 as compared with 0.50 for subdivisions and 0.69 for districts. Development blocks enjoyed the highest shape efficiency. The coefficient of variability (19.3 per cent) was also the lowest in their case.

Table 4

Punjab : Development Blocks Classified by Shape Efficiency Index, 1981

| Shape efficiency index | Development blocks |
|------------------------|--|
| More than 0.80 | <p>Firozpur (.99), Nurpur Bed (.99), Mahilpur (.99), Batala (.99), Tanda (.98), Ghall Khurd (.98), Shahkot (.98), Bhikhiwind (.98), Jandiala (.98), Muktsar (.97), Mehal Kalan (.97), Sehna (.97), Chamkaur Sahib (.97), Bhawani-garh (.97), Sultanpur Lodhi (.97), Jhunir (.96), Majri (.96), Garhshankar (.96), Patiala (.96), Kahnuwan (.96), Talwandi Sabo (.96), Chogawan (.96), Nihal singhwala (.95), Anandpur sahib (.95), Adampur (.95), Kapurthala (.95), Rurka Kalan (.94), Barnala (.94), Sangat (.92), Gurdaspur (.92), Tarsikka (.91), Nathana (.90), Bhopur (.89), Aur (.89), Dasua (.89), Nakodar (.89), Sidhawan Bet (.89), Mangat (.88), Phagwara (.88), Chola Sah b (.88), Sirhind (.88), Bathinda (.87), Faridkot (.86), Zira (.86), Nadala (.86), Guru Har Sahai (.86), Valtoha (.86), Sangrur (.86), Hashiarpur I (.85), Nur Mahal (.85), Nabha (.85), Gandiwind (.84), Mukerian (.84), Dhariwal (.84), Lambi (.84), Bhunga Jagraon (.83), Khadur Sahib (.82), Tarn Taran (.82), Sunam (.82), Ajnala (.82), Banga (.82), Machhiwara (.82), Kharar (.81), Talwara (.81), Abohar (.81), Fatehgarh Churian (.81).</p> <p>Total = 67</p> |
| 0.80 — 0.60 | <p>Lehragaga (.78), Dinanagar (.77), Rupnagar (.77), Majitha (.76), Kotkapura (.77), Kot Isse Khan (.76), Dera Bassi (.76), Dhar Kalan (.76), Pathankot (.75), Dhuri (.75), Kalanaur (.73), Dehlon (.73), Sri Har Gobindpur (.73), Rayya (.73), Dera Baba Nanak (.71), Jalandhar West (.71), Narot Jaimal Singh (.70), Bamial (.70), Fazilka (.70), Rajpura (.70), Nawashahr (.69), Malout (.68), Rampura (.68), Balachaur (.67), Mansa (.67), Naushehra Pannuan (.65), Kot Bhai (.65), Bagha Purana (.64), Pakhowal (.64), Saroya (.64), Bajwara* (.64), Ludhiana* (.62), Moga I (.61), Samana (.61), Doraha (.61).</p> <p>Total = 35</p> |

| Shape efficiency index | Development blocks |
|------------------------|--|
| 0.60 — 0.40 | Verka (.59), Patti (.59), Sudhar (.59), Budhlada (.58), Phul (.57), Jalalabad (.57), Malerkotla (.55), Phillaur (.57), Jalandhar East* (.52), Khuian Sarwar* (.50), Ahmadgarh* (.48), Bassi Pathana (.48), Samrala (.47), Moga II* (.44) Total = 14 |
| Less than 0.40 | Bhunerher* (.37), and Ghanaur* (.34) Total = 2 Grand total = 118 |

Average = 0.79 Standard deviation = 0.15
Coefficient of variability = 19.3 per cent

* Headquarters of these development blocks are located outside their territory

The shape efficiency of development block ranged from the lowest of 0.37 for Bhunerheri (Patiala district) to the highest of 0.99 for Batala (Gurdaspur district), Firozpur (Firozpur district), Mahipur (Hoshiarpur district) and Nurpur Bed (Rupnagar district). The low shape efficiency of Bhunerheri was attributed to outside-the-block location of its headquarters.

In about three-fifths of the blocks, shape efficiency index was more than 0.80 (Table 4). Among these, nine had their headquarters at the district headquarters and another sixteen at the sub-divisional headquarters. The shape efficiency of **sadar** development blocks, thus, conformed to that of the subdivision of the district in which these were located.

Development blocks formed at a later stage enjoyed greater shape efficiency.

It was particularly true of the blocks in the foothill and the border tracts. This was attributed to the experience gained in designing the blocks.

Shape efficiency of the development blocks did not bear any consistent relationship with that of districts or subdivisions in which these were located. Blocks in Kapurthala and Rupnagar districts were noted for high shape efficiency while the districts by themselves showed low shape efficiency. Patiala and Ludhiana districts had blocks with low shape efficiency while these of their own had high shape efficiency. This was further confirmed by practically an indifferent correlation ($r = -.05$) between the shape efficiency of subdivisions and their development blocks as also of districts and their development blocks ($r = -.14$).

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